



Republic of the Philippines
Department of Education
REGION X – NORTHERN MINDANAO
SCHOOLS DIVISION OF EL SALVADOR CITY

Office of Schools Division Superintendent

DIVISION ADVISORY
No. 187, s. 2022
November 14, 2022

*In compliance with DepEd Order No. 8, 2013,
this Advisory is issued not for endorsement as per DO No. 28, 2001
but for the information of DepEd Officials, Personnel/ Staff, and the concerned public.
(visit <https://depedelsalvadorcity.net>)*

**DEVELOPMENT OF CURRICULUM FRAMEWORK FOR THE K TO 12 STEM IN
EDUCATION 4.0**

The College of Education in Mindanao State University – Iligan Institute of Technology is conducting a research entitled **Development of Currciulum Framework for K to 12 STEM in Education 4.0** on November 8 to 30, 2022.

The identified teacher – respondents are all STEM teachers from St. Joseph Academy of El Salvador and Molugan National High School.

Attached is the communication for the complete details.

Further, this Office shall adhere to Equal Opportunity Principle (EOP). Hence, all actions shall be based solely on guidelines set with no discrimination on the account of age, gender, identity, sexual orientation, civil status, disability, religion, ethnicity, or political affiliation.

Participation in this activity shall be on voluntary basis. As such, the participants themselves shall shoulder any registration fees and travel/ incidental expenses. Further their participation shall be subject to the *no-disruption-of-classes policy* stipulated in DepEd Order No. 09, s. 2005 entitled *Instituting Measures to Increase Engaged Time-On-Task and Ensuring Compliance Therewith*, Section 3 of Republic Act No. 5546 (Policy on Contributions), and DepEd Order No. 66, 2. 2017 (Policy on Off – Campus Activities).

For information and guidance.


11.14.2022
OLGA C. ALONSABE, PhD, CESO V
Schools Division Superintendent 

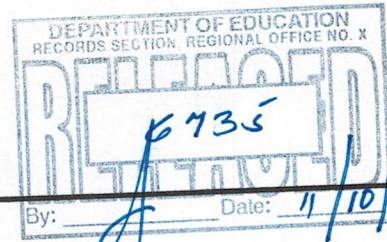
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Address: Zone 3, Poblacion, El Salvador City | Tel. No. (088) 555-0475
Website: www.depedelsalvadorcity.net | Email: elsalvador.city@deped.gov.ph



Republic of the Philippines
Department of Education
REGION X - NORTHERN MINDANAO



Regional Advisory No. 238, s. 2022
October 7, 2022

Complying with DepEd Order No. 8, s. 2013,
this Office issues this Advisory not for endorsement per DO 28, s. 2001,
but for the information of DepEd officials,
personnel/staff, and the concerned public.
(Visit deped10.com)

**DEVELOPMENT OF CURRICULUM FRAMEWORK FOR THE K TO 12
STEM IN EDUCATION 4.0**

The College of Education in MSU- Iligan Institute of Technology is
conducting a research titled **Development of Curriculum Framework for K
to 12 STEM in Education 4.0** on November 8-30.

Participation in this activity shall be on a voluntary basis. As such, the
participants themselves shall shoulder any registration fees and
travel/incidental expenses. Further, their participation shall be subject to the
no-disruption-of-classes policy stipulated in DepEd Order No. 9, s. 2005 titled
*Instituting Measures to Increase Engaged Time-on-Task and Ensuring
Compliance therewith*, Section 3 of Republic Act No. 5546 (Policy on
Contributions), and DepEd Order No. 66, s. 2017 (Policy on Off-Campus
Activities).

Attached is the letter from the MSU- Iligan Institute of Technology for
reference.

For more information, please email at jireh.solis@g.msuiit.edu.ph.

This Office directs the immediate and wide dissemination of this
Advisory.

ATCH.: As stated
To be indicated in the Perpetual Index
under the following subjects:

INVITATIONS GAMES

CLMD/nick



DepEd Regional Office X, Zone 1, Upper Balulang, Cagayan de Oro City
(088) 856-3932 | (088) 881-3137 | (088) 881-3031
Department of Education Region 10
region10@deped.gov.ph
<http://deped10.com>





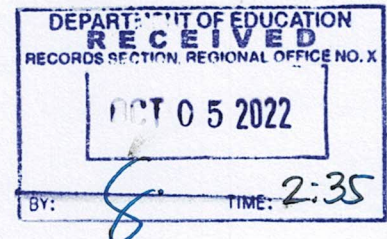
Republic of the Philippines
Mindanao State University
Iligan City 9200
Philippines

ILIGAN INSTITUTE OF TECHNOLOGY
COLLEGE OF EDUCATION
Center of Excellence for Teacher Education
Tel. (063) 223-2349
<http://web.msuiit.edu.ph/academics/colleges/ced/index.php>

October 5, 2022

DR. ARTURO B. BAYOCOT, Ph.D., CESO III
DepEd Regional Director, Region 10
Cagayan de Oro City

Through: NICK C. PAÑARES, Ph.D.
Education Program Supervisor, STEM
DepEd Region 10



Dear Dr. Arturo,

Greetings of Peace! The College of Education is conducting a project entitled Development of Curriculum Framework for K to 12 STEM in Education 4.0. This project intends to assess the alignment of the DepEd K to 12 Science and STEM curriculum with the competencies necessary for the 4th Industrial Revolution and develop a curriculum framework that aids the transition towards Education 4.0.

In this light, we would like to seek consent from your good office to conduct an interview and survey of the Senior High School Teachers who are teaching subjects under the STEM strand in Region 10 within the time frame of October 24- November 30, 2022. The aforementioned participants will help the researchers identify competencies and themes that can be incorporated into the proposed Education 4.0 framework. The conduct of interviews and surveys will be done after class hours to ensure the ease and availability of the teachers. To assist you in reaching a decision, I have attached this letter:

- (a) A copy of an ethical clearance certificate issued by the University
- (b) A copy of the project manuscript that includes the methodology of the research
- (c) A copy of the research instruments to be administered.
- (c) The list of schools, their assigned district, and divisions to be included as respondents based on cluster random sampling.

Upon completion of the study, I undertake to provide you with a bound copy of the research. Should you require any further information, you may contact, you may contact Jireh P. Solis or Michelle T. Clavido at 09667549899/09201708873 or email jireh.solis@g.msuiit.edu.ph / michelle.clavido@g.msuiit.edu.ph. We would be willing to review any concerns with you and answer any questions that you may have.

Your permission to conduct this study will be greatly appreciated. Thank you very much! God bless.

Yours truly,


RHEA F. CONFESOR, Ph.D.
Project Leader

Attachments:

- ✓ A copy of an ethical clearance certificate issued by the University
- A copy of the project manuscript that includes the methodology of the research
- A copy of the research instruments to be administered.
- The list of schools, their assigned district, and divisions to be included as respondents
based on cluster random sampling.



**MINDANAO STATE UNIVERSITY-
ILIGAN INSTITUTE OF TECHNOLOGY
COLLEGE OF EDUCATION**
(CHED Center of Excellence for Teacher Education)



RESEARCH ETHICS COMMITTEE APPROVAL LETTER

June 1, 2022

DR. RHEA F. CONFESOR
Department of Technology Teacher Education
MSU-Iligan Institute of Technology

Dear Dr. Confesor,

Greetings!

On behalf of the CED Ethics Review Committee, I am pleased to inform you we have reviewed and discussed your application to conduct the study entitled "*Development of Curriculum Framework for K to 12 Science in Education 4.0*". We have agreed that the conduct of this study is **approved** by the college research ethics committee.

We look forward to the success of your study and expect that you provide us with a final copy of your manuscript upon completion of your research.

Best regards,

A handwritten signature in black ink, appearing to read 'Amelia T. Buan'.

AMELIA T. BUAN, Ph.D.
Chair, College of Education Research Ethics Committee

Attachments:

- A copy of an ethical clearance certificate issued by the University
- ✓ A copy of the project manuscript that includes the methodology of the research
- A copy of the research instruments to be administered.
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Development of Curriculum Framework for K to 12 Science in Education 4.0

INTRODUCTION

Background of the Study

The Philippine government has initiated the K to 12 education program for the entire country in 2012. Such a move was to make the Philippine educational system at par with world standards. Nonetheless, such curricular shift has not fully considered the requirements as imposed by Education 4.0 as a consequence of the prevalence of fourth industrial revolution (4IR) at present and foreseeable future. Scientific discoveries and innovations built upon previous IR and internet have increased at an exponential rate that the scale, scope and complexity of changes are predicted to be unlike humans have ever experienced (PWR, 2019). Societies are being transformed from technological advances in Artificial Intelligence, the Internet of Things, Robotics, Advanced Materials, and Precision Medicine, and Big Data. Science and Technology Education is at the forefront of the ongoing and future changes in societies.

Critical thinking and scientific literacy, the goal of Science education, has increasingly been more relevant in the present times, especially so when responding to crises such as on health, ecology, or food. The reports both in research and news media showing the poor state of Scientific literacy are evidence of this pressing concern. To mention, reports include misconceptions of Science in undergraduate students (Hartley, Wilke, et al., 2011), the political debates of responding to pandemic or the news of ignorance of people on terminologies on disaster warnings that lead to casualties, have all showcased the importance of Science education even at present. How much more when 4IR is at its full strength. A given fact and reiterated by Schwab (2019) is “that the largest beneficiaries of innovation tend to be the providers of intellectual and physical capital—the innovators, shareholders, and investors—which explains the rising gap in wealth between those dependent on capital versus labor.”

DepEd and educational institutions therefore must review the Science curriculum to ensure that competencies developed in the basic education are valuable for the 4IR, particularly in producing graduates who shall become innovators and those that would fill the intellectually intensive jobs the economy requires. Thus, this project aims to investigate the

alignment of the current DepEd Science curriculum with the competencies necessary for the 4IR and Education 4.0 framework. Results of which will then provide a basis for the next phase of the project which is the development and validation of a curriculum framework that will help schools transition to Education 4.0.

Objectives

This project intends to:

1. Identify key Senior High School student competencies in Education 4.0.
2. Assess the alignment of the DepEd K to 12 Senior High School science curriculum with respect to emerging concepts, expected competencies, and constructs related to Education 4.0.
3. Develop and Validate a Curriculum Framework to aid in the transition of K to 12 Science to Education 4.0

Significance of the Study

This study aims to provide the K to 12 Science Teachers an information on how to teach students towards education 4.0. This research will impart knowledge and information to the Filipino Students on better planning, instruction and training for better preparation in the world of work and innovation in 4IR. To the School Administrators, the research outputs will guide them in supervising and managing their schools towards education 4.0.

Scope and Limitations

The study will focus on the area of Region 10, Northern Mindanao. Experts within the area and 14 DepEd Division will be included in the scope of the study. DepEd Senior High Schools that have Science Technology Engineering Mathematics (STEM) Strand and teachers in the same strand will be the respondents of this study as it aligns with the curriculum area that the study focuses on. The consultation with experts and validation of the curriculum framework will depend on those individuals who are willing to give time to participate in the study given the difficulties of the pandemic.

REVIEW OF LITERATURE

K to 12 Science

Scientific Literacy is the aim of the Philippines' science education where it aspires to equip the next generation of Filipino learners to be scientifically, technologically, and environmentally literate, productive members of society who manifest skills as critical problem solvers, responsible stewards of nature, innovative and creative citizens, informed decision-makers, and effective communicators. The aforementioned aim is the root basis in designing the science curriculum domains: understanding and applying scientific knowledge in local settings and global contexts whenever possible, performing scientific processes and skills, and developing and demonstrating scientific attitudes and values. Encircling these domains, are competencies that enable the students to become scientifically, technologically and environmentally literate and these competencies are: effective communication skills, critical and creative problem-solving skills, responsible stewardship of nature, innovative/inventive thinking, and informed decision making. All of the aforementioned domain is founded on the core learning area standard of the science curriculum, which is emphasized on the learners' demonstration of their understanding of the basic science concepts and application of science-inquiry skills. It is in this framework that the curriculum develops students' scientific values and attitudes to become equipped individuals ready to engage in relevant issues in science, technology, and in the environment.

Furthermore, the science curriculum integrates both science and technology in the social, economic, personal, and ethical aspects of life where it is anchored upon constructivism, social cognition learning model, learning style theory, and Gestalt psychology in educational pedagogy. These approaches applied a multi/interdisciplinary approach, science–technology society approach, contextual learning, problem/issue-based learning, and inquiry-based approach. The domains, pedagogies, and practices all adhere to achieving a scientifically and technologically literate Filipino learner (DepEd, 2013).

History of Education leading to Education 4.0

The delivery of formal education has changed since the onset of modern universities in the second century to the present 21st century. These significant changes are formed mostly in part by the economies throughout history from the first industrial revolution (1IR) in the 18th century using steam power to mechanize production, to 2IR that utilized electricity for mass production, to 3IR that used electronics and IT to automate production and to the 4IR, or the digital revolution is characterized by a fusion of digital, physical and biological spheres that are transforming production, systems and governance. Such economies impacted education, such as concepts of inclusive education, standardization, mass education, and knowledge economy (WEF, 2019).

Gilly Salmon (2019) divided formal education into eras. Education 1.0 is mainly about *Transmission*, where students go to schools and are consumers of information, whether through open universities or virtual learning environments. Education 2.0 is *Social*, brought about by Web 2.0 beginning in 2005 where the internet-enabled interaction and collaboration among individuals, and creation and contribution of ideas according to Salmon. During this time, VLEs became more social and interactive with the addition of blogs, wikis, chat, and online docs. These changes also led to the debate of openness of knowledge (Boulton, 2017) and universities offering MOOCs. Shortly after that is Education 3.0, which is about *Digital Lives and Mobility*. The Internet has become an integral part of students and is immersive as the majority of the students carry smart mobile devices through Web 3.0. Schools as well are becoming not only the main source of information.

Education 4.0 and the Existing Frameworks

Education 4.0 is the general term used by the education stakeholders to address the demands of 4IR. This term refers to the changing approaches in teaching, learning and curricula that are marked with the utilization of technology, accelerated remote learning, and flexibility. Educational institutions are to be made aware of this Education 4.0 as the World Economic Forum (WEF) has predicted that over thirds of desirable skills sets in the coming years have never been considered or practiced yet in the current times (WEF, 2019). The Organization for Economic Co-operation and Development (OECD) also has highlighted the need to respond to implications of Fourth IR to education particularly on the demands for knowledge and skills of graduates and on teaching and learning possibilities.

International organizations, WEF and OECD, have recognized the need for educational systems to prepare to transition to 4IR. Through separate consultations with key stakeholders, OECD and WEF were able to come up with these two separate learning frameworks for Education 4.0. These frameworks were not fully researched yet as the goal is to catalyze change (WEF, 2019). Both are also actionable and flexible for local contextualization (OECD, 2019).

WEF framework for education 4.0 that serves as a guide for countries for future learning. This framework is found in figure 1.

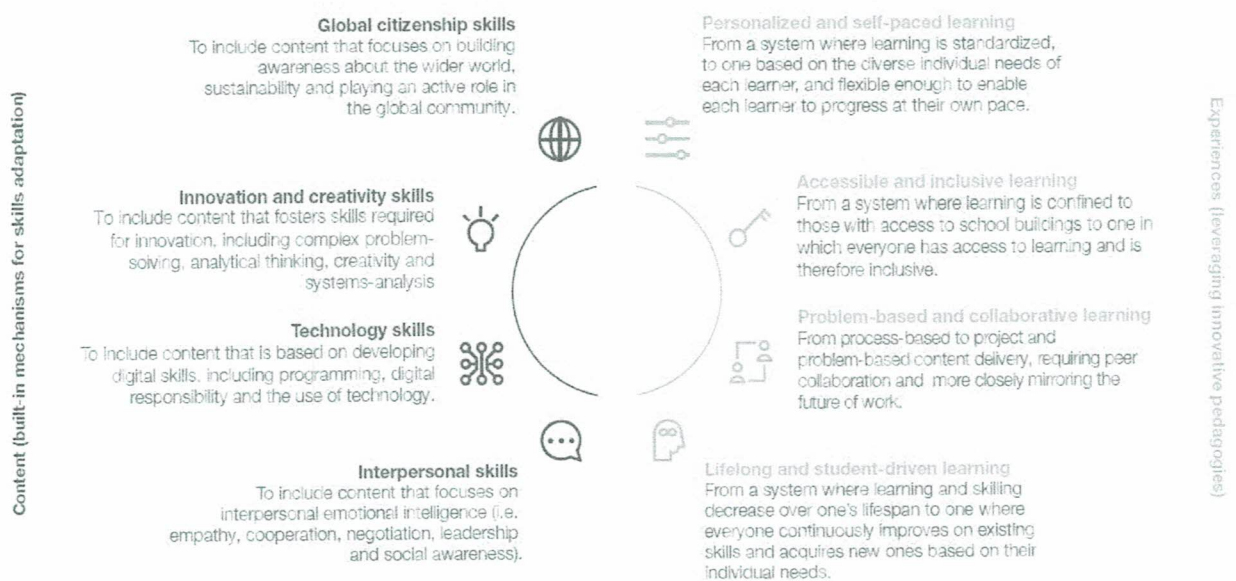


Figure 1. World Economic Forum Education 4.0 Framework

The framework consisted of two shifts necessary to align with industry 4.0. The first is on shifting learning content suggesting that children should be prepared to become productive contributors and responsible citizens of future economies. Such required skills are presented in the left side of the figure. The second is on shifting learning experiences for students that mirror the future world of work presented on the right side of the figure.

The Organization for Economic Co-operation and Development (OECD) in 2019 also proposed a learning framework in preparing for Industry 4.0 presented in figure 2

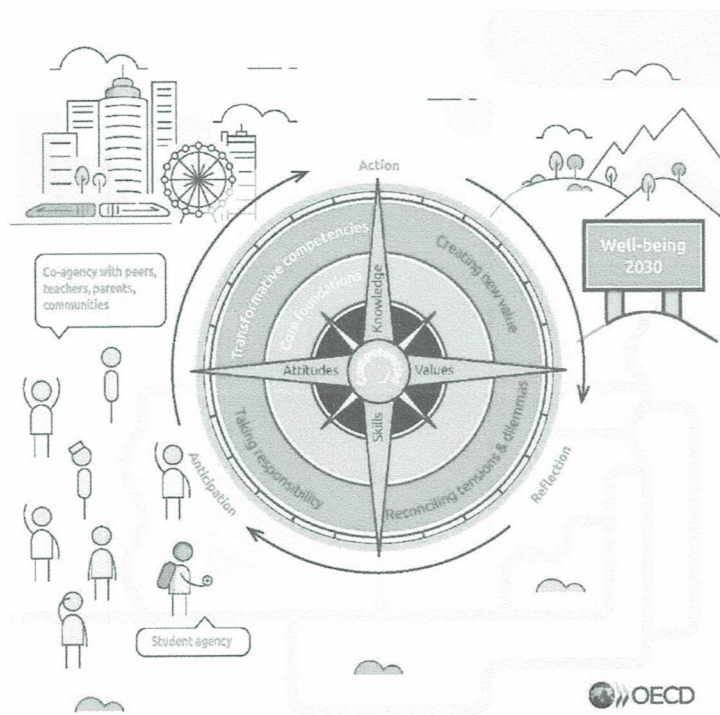


Figure 2. OECD Learning Compass 2030

The framework uses the compass metaphor indicating orientation for navigating competencies needed to shape the desired future for the students. The framework consists of seven elements, namely (1) core foundations which are the fundamental competencies for learning in the curriculum, (2) transformative competencies that include creating new value, reconciling tensions and dilemmas, and taking responsibility, (3) Student agency/ co-agency where students are capacitated to not only become the recipient of learning but become co-constructors as well, (4) Knowledge for 2030 refers to practicing disciplinary, interdisciplinary, epistemic and procedural knowledge, (5) Skills for 2030 involves using cognitive, metacognitive, social and emotional and practical and physical skills to carry out knowledge processes, (6) Attitudes and values for 2030 involve principles and beliefs in developing values of citizenship, and (7) Anticipation-Action-Reflection competency development cycle which is the iterative learning process for continuous improvement.

Core Foundations

In the future of education and skills for 2030, the OECD uses Core Foundations as a basis for developing student agency and transformative competencies that students will be grounded upon to become responsible and healthy members of society. The core foundations

were specified into three: cognitive foundations, health foundations, social and emotional foundations. Cognitive foundations include literacy- the ability to interpret, comprehend, create and use textual and visual information in making meaning, and numeracy- the ability to use mathematical tools, reasoning, and modeling to cope with varying demands of the digital environment. Both cognitive foundations are found to be an essential building block for 2030 and beyond but to be assimilated to the trends of modern society, these should be built upon digital literacy and data literacy where digitalization is contextualized in the cognitive foundations of learning (OECD, 2019).

Health as a core foundation elaborates the need for students to be physically and emotionally whole in order to learn and work effectively. Health rather than health literacy is used as a core foundation in the OECD Learning Compass for 2030 for the reason that students should be able to sustain healthy behaviors and not only be health-literate. With the advent of new technology, today's children have compromised both physical and mental health- less sleep, experiences harmful online behaviors and less engagement with physical activities (Aston, 2018 & Hooft Graafland, 2018) thus, this core foundation emphasizes the importance of teaching healthy behaviors that produces a quality life.

The OECD learning compass for 2030 also puts social and emotional foundations the spotlight. This core foundation envisions students to be socially and emotionally founded in order to learn a new skills and work well with others. Emotional regulation, collaboration, open-mindedness, engagement with others, self-awareness and self-regulation, resilience, trust, and empathy affects how an individual adapts to the ever-changing environment of the future. These constructs are anchored on moral and ethical foundations that teach the students to have the capacity to make decisions morally and reason ethically. Thus, it would be insufficient for the learners to be only thought on core knowledge and skills and not be equipped on their moral and ethical capacities for these are essential in acquiring transformative competencies for the future.

Transformative Competencies

The OECD Learning Compass for 2030 envisions equipped and competent future learners who will not just be able to acquire knowledge and skills but can mobilize knowledge, skills, attitudes, and values to meet the demands and adapt to the uncertainties of this complex world. Students need to be empowered to take part in shaping the world that

achieves well-being and sustainability for oneself, for others, and the planet. This holistic concept is embodied in one of the elements of the Learning Compass for 2030- Transformative Competencies. With Industry 4.0 where the advances of artificial intelligence (AI) change the demands of the labor market, the highlight of skill development shifts towards human capacity where AI cannot meet upon. These human capacities were identified into three: creating new value, reconciling tensions and dilemmas, and taking responsibility- all of which are the transformative competencies that OECD focused on in helping students thrive in shaping the future.

The three transformative competencies are aspired to be taught and learned in schools through curricula and pedagogy incorporation. Creating new value holds upon the concept of innovation for inclusive growth and sustainable development where students are empowered to develop new knowledge, insights, ideas, techniques, strategies, and solutions in addressing timely problems. This competency elaborates the learners' ability to innovate and act entrepreneurially by taking informed and responsible actions. In order to do so, they must have sense of purpose, curiosity, open mindset, creativity, agility, ability to critically think, collaborate, adapt and manage risks- all of which help students to create new value. Another competency implied by the learning compass for 2030 is reconciling tensions and dilemmas. Developing students' ability to handle tensions, dilemmas, trade-offs, understand and work alongside the needs, interests, and perspectives of others is found to be an essential competency that students need to learn to cope with Industry 4.0. This competency, according to Haste (2001) equips the learners to manage diversity and dissonance in a creative and coping way. Students need to have cognitive flexibility and perspective-taking skills, empathy, respect, creativity, have problem-solving skills and conflict resolution skills, resilience, tolerance for complexity and ambiguity, and have a sense of responsibility towards others. The third transformative competency considers the ethics of action which is taking responsibility. By acting responsibly, students should show moral and intellectual maturity through critically analyzing and evaluating alternatives in an ethical lens (Nussbaum, 1997). In the midst of uncertainty, students should know how to meet challenges responsibly by embodying student agency and co-agency. Such ability requires students to have a locus of control, a sense of integrity, compassion, respect, self-awareness, self-regulation, reflective thinking, and trust. The three transformative competencies in the OECD learning compass for

2030 highlights the vision where our next generation of leaders becomes morally and ethically mature agents that ensures the benefit for all in the growing power of artificial intelligence (OECD, 2019).

Student Agency/Co-Agency

Student agency is expounded on developing students' sense of responsibility and purpose to influence people, events, and circumstances for the better. OECD said that "It is about acting rather than being acted upon; shaping rather than being shaped; and making responsible decisions and choices rather than accepting those determined by others.". This element is the root of the OECD's Learning Compass for 2030. Student agency is drawn a line with student autonomy, student voice, and student choice, rather student agency is to have an individual capacity to set a goal, reflect and act responsively to effect change. This develops students' identity and sense of belonging where they can rely on motivation, hope, self-efficacy, and growth mindset that leads them towards well-being. Thus, student agency enables the students to flourish and thrive in society.

In exercising students' agency, they need support from parents, peers, teachers, and community; where the concept of Co-agency is implied. The learning compass for 2030 included students' co-agency in support of student agency. This is referred to as "collaborative agency" where a person's environment influences his or her sense of agency. Students, parents, teachers, and the community work together in building co-agency- this is OECD's vision of an effective learning environment. Teachers play a role in designing a learning environment that is anchored on the principle of student agency, peers influence each other's agency at the student-to-student level, parents also play a vital role as the co-agent of the student's learning, the wider community serves its part in students' learning environment and collective agency is being achieved in a larger scale (OECD, 2019).

Knowledge for 2030

The OECD learning compass for 2030 recognizes four types of knowledge that include the theoretical concepts, ideas, and experience-based understanding of the world, namely: disciplinary, interdisciplinary, epistemic, and procedural knowledge. Disciplinary

knowledge holds subject-specific concepts and detailed contents in specific disciplines. In the light of Industry 4.0, Luckin and Issroff (2018) said that people should have knowledge of basic AI concepts and programming, ethics of AI, the engineering of AI systems, digital literacy, online safety, and data literacy. With this said, disciplinary knowledge provides the essential structure and foundational concepts where all the other types of knowledge can be acquired and developed. Another knowledge distinguished in the learning compass for 2030 is Interdisciplinary knowledge or the knowledge of “Connecting the dots” which emphasizes thinking across disciplines in identifying solutions and solving complex problems. With this knowledge, students learn to transfer key concepts and identify interconnectedness from and across different subjects and disciplines. Project-based learning as pedagogy and approach to learning is also associated with Interdisciplinary knowledge as it combines knowledge from disciplines to work on difficult topics. Furthermore, the knowledge that the learning compass for 2030 also includes epistemic knowledge- knowing how to think and act like a practitioner. This knowledge allows the students to have an understanding on the different forms and uses of knowledge that inclines to their values and ethics to purposefully work in contributing a holistic future outcome. Procedural knowledge or the knowledge of “how” is also one of the highlights of the learning compass. This knowledge empowers the students to discover the systems, design, patterns, and processes of problems in order to arrive at an accomplished solution (OECD, 2019). The procedural knowledge and disciplinary knowledge function together according to the OECD and Benander (2018) that these knowledge should also be facilitated by teaching students the skills, attitudes, and ability to transfer knowledge in order to achieve deeper understanding. Concluded by Scott (2015), learning should be emphasized not just in learning to know but also in learning to do, learning to be, and learning to live together- all of which is articulated in OECD’s Learning Compass for 2030.

Skills for 2030

The aforementioned statement of Benander (2018) on the inclusion of skills in facilitating knowledge is added with Klieme’s (2004) assert that “higher competency levels are characterized by the increasing proceduralisation of knowledge, so at higher levels, knowledge is converted to skills”. The skills encapsulated in the Learning Compass for 2030 highlight the complementary work of both knowledge and skills where the two are

inseparable and is developed together. Thus, skills are defined as the ability to use one's knowledge in a responsible manner to achieve a goal.

The OECD Learning Compass 2030 identifies three different types of skills: (1) cognitive and meta-cognitive skills- implies critical thinking, creating thinking, learning-to-learn, and self-regulation; (2) Social and emotional skills- includes empathy, self-efficacy, responsibility and collaboration; (3) Practical and physical skills- the use of new information and communication technology devices. In the emerging advances of technology, routine tasks has been replaced allowing new non-routine jobs to occur where cognitive, social and emotional skills are utilized. Workers in the future will have the need to develop new skills that require flexibility and a positive attitude towards learning and curiosity. In the future education for 2030, social and emotional skills will be equally or even be more emphasized as cognitive skills in becoming a responsible citizen (OECD, 2019).

Attitudes and Values for 2030

Another key component of the OECD Learning Compass for 2030 develops the students' principles and beliefs to strengthen their ability to make decisions, judgements, actions and behaviors for their individual self, society and environmental well-being. Core shared values of citizenship such as respect, fairness, personal and social responsibility, integrity and self-awareness at school helps establish ties in institutions and communities to build sustainable societies. Hence, these attitudes and values are emphasized to be integrated into curriculum framework where the notable use of artificial intelligence makes more room for ethics on the education agenda. The OECD emphasized that knowledge, skills, attitudes and values should be developed interdependently to highlight their inter-relatedness and not separately as to competing concepts (OECD, 2019). Thus, the future education envisions that the people will gain advantage from the capacity to evaluate the extent to which technology may or may not ensure a fair and equitable world for the next generation.

Anticipation-Action-Reflection

An iterative learning process called as Anticipation-Action-Reflection (AAR) cycle is included in one of the elements of the OECD Learning Compass for 2030. The AAR is where students are given the opportunity to improve their thinking and their intentional response that contributes to the collective well-being. The cycle is built upon a range of other learning

processes it consists of three phases: (1) Anticipation- learners understand their own and other's intentions and use that ability to perceive the short and long-term consequences of their action, (2) Action - learners process the anticipated consequences and then act in a wise manner as a response to meet the goal of contributing to well-being, (3) Reflection- the stage where learners are then able to have an improved thinking and deeper understanding in aligning future actions with their shared values and intentions to successfully adapt in society's demands. The three stages help the learners widen their ability to make decisions that consider their own and other people's benefit that all together contributes to the holistic development of the community (OECD, 2019).

The OECD Learning Compass for 2030 vis-à-vis the K to 12 Science Curriculum

The competencies incorporated in the K to 12 Science Curriculum and World Economic Forum are aligned to the OECD's Learning Compass for 2030 where the transformative competencies, knowledge, and skills of the future education serve as the baseline for the alignment. The OECD's broad vision of competencies for students to thrive recognizes the evolving learning framework that leads to the aspiration of what the future of education would look like. Thus, the learning compass gauges the curriculum alignment.

The table below shows the overview of the curriculum content mapping of the OECD's Transformative Competencies, Knowledge and Skills to the K to 12 Science Curriculum and K to 12 STEM Curriculum with the World Economic Forum.

Table 1

Curriculum Alignment of the OECD to the K to 12 Science Curriculum and World Economic Forum

OECD Learning Compass for 2030		K to 12	Science Curriculum & STEM SHS Strand	World Economic Forum
Transformative Competencies	Creating New Value			
	Reconciling Tensions and Dilemma			

	Taking Responsibility			
Knowledge	Disciplinary			
	Interdisciplinary			
	Procedural			
	Epistemic			
Skills	Cognitive & Metacognitive			
	Practical & Physical			
	Social & Emotional			

The three transformative competencies (creating new value, reconciling tensions and dilemma and taking responsibility), knowledge and skills of the learning compass for 2030 have been observed to only a few competencies in the K to 12 Science and STEM Curriculum. This observation indicates that in the OECD's transformative competencies- Creating New Value and Taking Responsibility- are mostly in line with the competencies identified in the K to 12 curriculum while there were only a few competencies that are in line with Reconciling Tensions and Dilemma. Specific key constructs such as sense of purpose, empathy, cognitive flexibility, perspective-taking skills, conflict resolution, resilience, and tolerance for complexity and ambiguity were less likely seen in both of the curriculums aligned. These identified constructs all aim to help students acquire an in-depth understanding of opposing ideas, develop arguments to support their own idea, and find solutions to dilemmas and conflicts.

On the other hand, the Science and STEM K to 12 Curriculum has competencies that lie more in the Knowledge and Skill domain of the OECD's Learning Compass for 2030. The scientific, environmental and technological literacy that the curriculum imposes has competencies that correspond to the disciplinary, interdisciplinary and procedural knowledge of the learning compass along with the cognitive/metacognitive skills and practical/physical skills in the Skill Domain. The epistemic knowledge, the social and emotional skills in the OECD's learning compass were the constructs less likely matched in the K to 12 Science and STEM Curriculum. Epistemic knowledge empowers students to find their purpose in learning to better apply and extend their disciplinary knowledge while the social and emotional skills

include self-efficacy, empathy, responsibility, and collaboration- both are vital constructs that promote student agency and co-agency that the OECD believes to be part in the future of education. Thus, there stands a gap that the K to 12 Science curriculum should meet.

METHODOLOGY

This chapter discusses the study's research methodology, research design, research setting, research instrument to be used, research subjects and data gathering procedure.

Research Design

This study will utilize an exploratory sequential mixed methods research design. This entails the conduct of multiple case study of STEM Experts and DepEd STEM Master teachers on their integration of education 4.0 competencies through interviews using two rounds of Delphi technique, curriculum content mapping, and document analysis collection to identify necessary Education 4.0 competencies. From these identified competencies, a survey will then be conducted to DepEd Science teachers to determine extent of integration of key competencies.

Research Setting

This study will be implemented in Region 10 of the Northern Mindanao, Philippines composing of 14 DepEd School Divisions for DepEd respondents and 5 provinces (Bukidnon, Camiguin, Lanao del Norte, Misamis Oriental and Misamis Occidental) for the STEM experts. The survey and case study to be conducted in the study will gather its participants within the region.

Research Subjects

a. Case Study:

- STEM Experts- The respondents of the study are experts located within Region 10 in the Philippines, are a master's or doctorate holder, have at least 5 years of teaching experience and have mentored graduate and undergraduate thesis students.

Slusarczyk, B. (2018). Industry 4.0 : are we ready? *Polish journal of management studies*, 17, 232-248.

Technical Report: Curriculum Analysis of the OECD Future of Education and Skills 2030.
Retrieved from

https://www.oecd.org/education/2030-project/contact/Technical%20_Report_Curriculum_Analysis_of_the_OECD_Future_of_Education_and_Skills_2030.pdf

Tripney and Hombrados (2013). Empirical Research in Vocational Education & Training 2013, 5:3. Retrieved from <http://www.ervet-journal.com/content/5/1/3>

WEF (2020). Schools of the Future Defining New Models of Education for the Fourth Industrial Revolution. World Economic Forum, Geneva. Retrieved from http://www3.weforum.org/docs/WEF_Schools_of_the_Future_Report_2019.pdf

Attachments:

- A copy of an ethical clearance certificate issued by the University
- A copy of the project manuscript that includes the methodology of the research
- ✓ A copy of the research instruments to be administered.
- The list of schools, their assigned district, and divisions to be included as respondents
based on cluster random sampling.

**MINDANAO STATE UNIVERSITY
ILIGAN INSTITUTE OF TECHNOLOGY
College of Education
Department of Science and Mathematics Education
Andres Bonifacio Ave., Iligan City
9200 Lanao del Norte**

Respondents
Science Experts
Iligan City

Dear Ma'am/Sir,

Greetings of Peace! The College of Education is conducting a project entitled Development of Curriculum Framework for K to 12 TLE in Education 4.0. This project intends to assess the alignment of the DepEd K to 12 TLE curriculum with the competencies necessary for the 4th Industrial Revolution and develop a curriculum framework that aids the transition towards Education 4.0.

In this light, we would like to invite you to participate in the said research. We ask you to partake in a survey and interview to help us identify competencies and themes that can be incorporated into the proposed Education 4.0 framework. All information will be kept confidential as your participation is highly valued.

Should you want to know more about the research study, you may contact Jireh P. Solis or Michelle T. Clavido at 09667549899/09201708873 or email jireh.solis@g.msuiit.edu.ph/ michelle.clavido@g.msuiit.edu.ph. We would be willing to review any concerns with you and answer any questions you may have.

If you are willing to participate, we request that you read and sign the attached consent form. Thank you very much! God bless.

Yours truly,

RHEA F. CONFESOR, Ph.D.
Project Leader

Consent Form

To Whom It May Concern:

I am (name) _____, _____ of age, a resident of _____, give my full consent to be a participant of this study entitled: Development of Curriculum Framework for K to 12 Science in Education 4.0.

I am aware that my role as a participant in this study includes:

1. accomplish the self-answer sheet and return it to the researcher after answering (30 minutes or less estimated time to answer);
2. participate in the survey which shall be conducted after accomplishing the self-answer sheet (duration of 1 hour or less);
3. answer further questions by the researcher, pertinent to the information already gathered from me, at some other time when needed at my convenience.
4. provide other sources of data or evidence that support information shared during the survey, which may include video documentation and presentation of lesson plans, photos, certificate of participation, research undertakings, etc.

I am also aware that my rights and privileges as a participant of this study include:

1. not to answer questions that would put me in a difficult situation;
2. withdraw my participation anytime regardless of whatever reasons;
3. request for the return or destruction of the information, data, and documents gathered by the researcher from me to ensure the non-inclusion of such in the study.

I also know that the responsibilities of the researcher to me as a participant of this study include:

1. inform me in advance of the schedule of the interview;
2. provide me a copy of the audio transcripts as well as a draft of the study for me to review.
3. provide me with a copy of the final results of the study;
4. give me a Certificate of Participation for my role in the study;
5. reimburse me of incidental expenses incurred during my participation of the study;
6. store data securely following CED protocol;
7. ensure that my identity as a participant of this study shall remain confidential.

I have read and fully understood my roles, rights, and privileges and the responsibilities of the researcher to me as a participant in this study. I hereby agree to be included as a participant in this study.

Signature Over Printed Name

Date Signed: _____

COMPETENCY EVALUATION

Introduction

The Fourth Industrial Revolution demands new competencies. The future jobs will be widely influenced by the rapid technological advancement and will require today's schools to adapt and equip children with the skills to create a more inclusive, cohesive and productive world (World Economic Forum, 2020). Thus, the education systems should now be considered as part of a larger ecosystem where shared responsibility is open to the wider community in approaching curriculum design and learning progression (OECD, 2019). The OECD and WEF have developed frameworks for Education 4.0 that feature knowledge, attitudes and skills necessary for learners to become productive contributors and responsible citizens of future economies. The competencies featured in both frameworks are featured in this questionnaire. This questionnaire will help identify competencies that can be incorporated into the proposed Education 4.0 framework.

Direction: Indicate as to what extent you agree or disagree to each of the following descriptions of competencies are necessary for learners to be successful in your class by checking the appropriate option with the indicated value scale shown below.

- | | |
|-------------------------------|-------------------|
| 1- Strongly Disagree | 4- Agree |
| 2- Disagree | 5- Strongly Agree |
| 3- Neither Agree nor Disagree | |

Competencies	1	2	3	4	5
1. The ability to comprehend, interpret, use and create textual and visual information in various formats, contexts and for diverse purposes (making meaning based on encoding and decoding signs/sign systems).					
2. The ability to use mathematical tools, reasoning and modelling in everyday life, including in digital environments					
3. Digitally literate in reading, interpreting, making meaning of and communicating through digital texts and sources from a variety of online media.					
4. The ability to read, work with, analyse and argue with data, and understand "what data mean, including how to read charts appropriately, draw correct conclusions from data, and recognise when data are being used in misleading or inappropriate ways" (Carlson et al., 2011[3]).					
5. Have the knowledge, skills, attitudes, and values to lead a physically active and healthy life but is able to sustain healthy behaviors.					
6. Moral and ethics or the capacity to make decisions and judgements that are moral and to act in accordance with such judgements.					
7. Critical thinking in finding answers to problems					
8. Creativity in finding different approaches to solving problems					
9. Collaboration or ability to successfully work toward a common goal with others.					
10. Mental agility in trying out new ideas					

11. Understanding or managing risks when exploring new ideas					
12. Adaptability to learn new skills and behaviours in response to changing circumstances					
13. Sense of Purpose towards new ideas, perspectives and experiences					
14. Curiosity or the strong desire to know or learn something					
15. Open mindset or adaptability to a wide variety of ideas, arguments, and information.					
16. The ability to develop a sense of resilience in making complex and difficult decisions					
17. Tolerance for complexity or the willingness to understand complex views.					
18. Tolerance for ambiguity by being comfortable with uncertainties, have low fear response to the unfamiliar or to change, accepts novelty and is not bound by categorization.					
19. Sense of Cognitive Flexibility towards different point of views					
20. Perspective-taking Skills or the capacity to consider a situation from a different point of view					
21. Sense of Responsibility Towards Others					
22. Show empathy in understanding and share the feelings of another or others.					
23. Respect towards others' choice and decisions					
24. Problem solving skills in identifying conflict and devising new and different solutions to seemingly complex problems.					
25. Creativity in finding solutions to problems					
26. Conflict resolution or the ability to create solutions and negotiate disagreement					
27. Critical thinking in analyzing and forming judgment of one's action and the actions of others.					
28. Reflective thinking or the competency to take the bigger picture and understand or reflect all of its consequences.					
29. Locus of control or the extent of being able to have control over the events that influence their lives					
30. Sense of self-awareness towards one's own beliefs from others					
31. Sense of self-regulation towards new circumstances or environment					
32. Sense of integrity or the quality of being honest and consistent to one's moral principles.					
33. Compassion towards others' state, views, decisions or opinions					
34. Respect towards one's feelings, wishes, rights, or traditions					
35. The ability to build trust before taking responsibility.					
36. The ability to identify the beliefs and characteristics that make up oneself.					
37. Sense of belongingness or being connected with others.					

38. Motivation or one's perseverance, openness to problem-solving, perceived control over success and perceived responsibility for failing in the process of learning.					
39. Being optimistic or having positive expectations with respect to events and circumstances in one's life.					
40. Self-efficacy or the beliefs in one's ability to execute tasks and achieve goals					
41. Believes that with work, individual skills can improve over time.					
42. Moral agency or the ability to make decisions that recognize the rights and needs of others					
43. Social agency or the understanding of the rights and responsibilities related to the society in which they live.					
44. Economic agency or the ability to identify and seize opportunities to contribute to the local, national or global economy.					
45. Creative agency or adding new value to the world by using one's imagination and ability to innovate, whether for artistic, practical, or scientific purposes					
46. Interactive or being involved in collaborative work.					
47. Mutually Supportive Relationships with parents, teachers, the community, and with each other.					
48. Teamwork or the ability to build healthy relationships at school, home, and in the community.					
49. Collective agency or the ability of putting differences and tensions aside and come together to achieve a common goal (Leadbeater, 2017).					
50. Disciplinary knowledge or an individual's understanding of the subject matter concepts and how these concepts relate to form the larger body of knowledge.					

51. Interdisciplinary knowledge or understanding the interconnectedness of concepts across various disciplines					
52. Epistemic Knowledge or the knowledge of knowing how to think and act like a practitioner					
53. Procedural knowledge or the knowledge of "how" that shows the understanding of how a task is performed and learned through a structured process.					
54. Cognitive Skills or "the mental action or process of acquiring knowledge and understanding through thought, experience, and the senses"					
55. Meta-cognitive skills "Thinking about thinking" or the awareness and understanding of one's own learning and thought processes					
56. Practical Skills in using and manipulating materials, tools, equipment and artefacts to achieve particular outcomes.					
57. Physical Skills in using physical tools, operations and functions.					
58. Social skills or the ability to show assertiveness in social situations, maintain positive relations, and show concern for the well-being of others.					
59. Emotional Skills or the ability to control emotional responses to show more resilience in stressful situations, and reflect on one's individual curiosity					
60. Practices equality by being in an equal state with others.					
61. Social equity or showing impartiality, fairness and justice for all people in society					
62. Justice is the moral principle determining just conduct.					
63. Human dignity is the right of a person to be valued and respected for their own sake, and to be treated ethically.					
64. Global-mindedness or knowledge of global issues and universal values and the capacity to act collaboratively and responsibly to find global solutions for global challenges.					
65. Cultural diversity or being open towards people from other cultures and having respect for cultural otherness and values of human dignity.					
66. Freedom, the power and resources to fulfill one's purposes.					
67. Democracy in recognizing the importance of the whole population and its power as one.					
68. Anticipation or the ability to develop an awareness of how actions are taken today might have consequences in the future to better understand issues and manage tensions and dilemmas.					
69. Action or the ability to have an investigative response that may be oriented towards taking responsibility, or creating new value or directed towards making changes					
70. Reflection or the ability to make meaning from one experience into the next with a deeper understanding of its relationships with and connections to other experiences and ideas.					

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based on cluster random sampling.



All STEM Teachers from the following list of schools will be the respondent to our project entitled, "Development of Curriculum Framework for K to 12 STEM Curriculum in Education 4.0". The list of schools was identified using the cluster random sampling technique where schools offering STEM Strands in every Division level were randomly selected by the researchers.

SCHOOL	DIVISION	DISTRICT
1. Pangantucan Community High School	Bukidnon	Pangantucan
2. Kibawe National High School	Bukidnon	Kibawe
3. Central Mindanao University Lab. HS	Bukidnon	Baungon
4. Pilgrim Christian College	Cagayan de Oro City	Cagayan de Oro City Central I District
5. Misamis Oriental General Comprehensive High School	Cagayan de Oro City	Opol
6. University of Science and Technology of Southern Philippines	Cagayan de Oro City	Cagayan de Oro City Central I District
7. Fatima College of Camiguin	Camiguin	Catarman
8. Camiguin NHS	Camiguin	Camiguin NHS
9. Gingoog City Colleges Inc.	Gingoog City	Gingoog City East-1 District
10. Gingoog City CNHS	Gingoog City	Gingoog City West-1 District
11. St. Joseph Academy of El Salvador	El Salvador City	District I
12. Molugan National High School	El Salvador City	District I
13. Iligan Computer Institute-Iligan City	Iligan City	Iligan City East I District
14. Sta. Filomena	Iligan City	Iligan City North I District
15. MSU-IIT Integrated Developmental School	Iligan City	Iligan City East I District
16. Christ The King College de Maranding	Lanao del Norte	Bacolod
17. Pantar National High School	Lanao del Norte	Pantar
18. Mindanao State University - Maigo School of Arts and Trades	Lanao del Norte	Bacolod
19. San Isidro College	Malaybalay City	Malaybalay City District IV
20. Casisang Senior High School	Malaybalay City	Malaybalay City District V
21. Bukidnon State University	Malaybalay City	Malaybalay City District I
22. Christian Samaritan Health Services and Technical School, Inc	Misamis Oriental	Tagoloan

23. Medina NCHS	Misamis Oriental	Tagoloan
24. Mindanao State University at Naawan- Integrated Developmental School	Misamis Oriental	Naawan
25. Sacred Heart College	Misamis Occidetal	Aloran
26. Calamba National Comprehensive High School	Misamis Occidetal	Calamba
27. MSU - Lopez Jaena Community High School	Misamis Occidetal	Lopez Jaena
28. Stella Maris College	Oroquieta City	Central District I
29. Misamis Occidental NHS	Oroquieta City	Central District I
30. Misamis University	Ozamiz City	Central District I
31. Ozamiz City National High School	Ozamiz City	Ozamis City District I
32. St. Michael's High School, Tangub City Inc.	Tangub City	Tangub Central District
33. Tangub City National High School	Tangub City	Tangub Central District
34. Northwestern Mindanao State College of Science and Technology	Tangub City	Tangub South District
35. Mountain View College Academy	Valencia City	District I
36. Catumbalon National High School	Valencia City	District IV